Examining the Factors Influencing Electric Vehicle Adoption Intention in the Himalayan Region

SYNOPSIS OF THE THESIS

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DECLARATION

I hereby declare that the dissertation synopsis entitled Examining **the Factors Influencing Electric Vehicle Adoption Intention in the Himalayan Region to** be submitted for the partial fulfilment of the Degree of Doctor of Philosophy is my original work and the dissertation has not formed the basis for the award of any degree, diploma, associateship or fellowship of similar other titles. It has not been submitted to any other University or Institution for the award of any degree or diploma.

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Introduction:

In recent years, India has been facing problems with energy and the environment. On the one side, energy consumption and demand have been continuously increasing due to population rise and industrialization. In 2016, India's foreign oil dependence exceeded 80% and this will exceed 90% around 2025 (Li and Wang, 2019; Singh et al., 2021). On the other side, the issue of environmental pollution is becoming severe. In 2021, India had the 35 most polluted cities out of 50 of the world's most polluted cities list and New Delhi ranked one (IQAir, 2021). The Indian transport sector accounts for 55% of the overall oil consumption and is responsible for 14 % of carbon emissions (Bhat et al., 2022). The road transport vehicles in India have grown from 17.6 crores in 2013 to 29.6 crores in 2019 with an annual average growth rate of 6% (Statista, 2021), which caused rising fuel consumption and a large amount of carbon emission. Therefore, the carbon emission of road transport vehicles is becoming severe and the Government of India (GoI) is working on different strategies and policies to reduce the carbon emission. Electric vehicle (EV) mobility is one of the critical policies among them.

Adoption of EVs is crucial to reducing oil fuel consumption and environmental pollution (Singh et al., 2020). The literature has shown that EVs provide more energy-saving and pollution reduction benefits as compared with internal combustion engine vehicles (ICEVs) (Jaiswal et al., 2021; Vidhi and Shrivastava, 2018; Dua et al., 2021). Considering energy saving and pollution reduction advantages offered by EVs, the GoI has set a target of 100% EVs by 2030 (Tarei et al., 2021). To achieve this target, the GoIstarted 'National Electric Mobility Mission Plan 2020. Also, for the adoption of EVs, the GoI implemented the 'Faster Adoption and Manufacturing of EVs (FAME)' scheme by giving subsidies to EV purchases in 2017 (Singh et al., 2021). Under the continuous efforts of GoI, in February 2022, EV sales grew by 297% (FADA, 2022).

Himachal Pradesh is a hilly state located in the North-Western Himalayan ranges along with a famous destination; hence, anthropogenic pressure applied by tourists is immense. The concentration of suspended particulate matter (SPM) for the state is approximately 85 µg/m3 for the year 2015-16, which is higher than the national standard limit of 60 µg/m3 (PCB H. P., 2016). In addition, the annual average temperature in the state is expected to rise by 2.7 ± 0.7 Ċ

by 2030 compared to 1970 levels (Batta, 2016). Therefore, to reduce road transport emissions and conserve the sensitive Himalayan ecosphere, the state of Himachal Pradesh became one of the first states in India to run electric passenger transport buses (EPTBs). Presently, the Himachal Road Transport Corporation (HRTC) is running 75 EPTBs and 50 electric taxis, and the state has set a target of 15% new EVs by 2025 (GoHP DOT, 2022). To achieve this target, the state government is going to implement a series of incentive policy measures for EV adoption, such as purchase incentives, and tax and fee waivers. Also, the state government would put more compulsion on consumers to adopt EVs.

Review of Literature:

Since EV is a comparatively new technology in India, few types of research have been conducted on the adoption intentions of EVs to analyze the individuals' acceptance and the consumers' adoption intentions towards this emerging technology (Bhat et al., 2022; Sahoo et al., 2022; Jaiswal et al., 2021; Shalender and Sharma, 2021; Khurana et al., 2020). Despite China, the USA, and Europe, EVs are a relatively new technology in the Indian automobile industry (Singh et al., 2021). At the same time, the GoI has observed the profits of EVs adoption, and strategies and policies have been framed toward upgrading their adoption (Sahoo et al., 2022). Although it is foremost to use EVs for worldly-wide concerns involving environmental and transportation system sustainability, acceptance by the public and consumers should be considered to speed up the adoption (Rezvani et al., 2015). Acceptance of individuals and consumers regarding EVs adoption depends upon individual decision-making. Therefore, identifying the factors encouraging and extending the adoption of EVs at the personal level is of considerable significance (Singh et al., 2020).

Electric vehicle adoption intentions (EVADINT) from the individual viewpoint have been investigated by several researchers in terms of factors impacting adoption behavior (Singh et al., 2020; Kumar and Alok, 2020; Huang and Ge, 2019). Moreover, these factors of EVADINT were expressed in terms of self-interest factors (Xia et al., 2022; Asadi et al., 2021; Singh et al., 2020) and socio-psychological factors (Jain et al. 2021; Shalender and Sharma, 2021; Adnan et al., 2017). Furthermore, these factors are primarily based on models that are self-regarding - that is,

social cognitive theory (Jaiswal et al., 2022; Wang et al., 2021;Sovacool, 2017), theory of planned behaviors (TPB) (Asadi et al., 2021; Sahoo et al., 2022; Jayasingh et al., 2021; Shalender and Sharma, 2021; Huang and Ge, 2019; Haustein and Jensen, 2018), the theory of reasoned action (Malik, C., Yadav, 2021; Alzahrani et al., 2019; Nosi et al., 2017), innovation diffusion theory (Verma et al., 2020; Tu and Yang, 2019), consumption value theory (Han et al., 2017), and the technology acceptance model (Adu-Gyamfi et al., 2022; Jaiswal et al., 2021; Wu et al., 2019; Wang et al., 2018), and as well as a unified theory of acceptance and use of technology (UTAUT) (Zhou et al., 2021; Gunawan et al., 2022; Abbasi et al., 2021; Khazaei and Tareq, 2021; Bhat et al., 2022; Jain et al., 2021). Researches often point out at need for analyzing the adoption behavior and the social-psychological variables of EVADINT as well (Sahoo et al., 2022; Asadi et al., 2021), which gives an integrated investigation of psychological procedures that lead to behavioral intent. Consequently, there is necessary to recognize inspirations for EVs adoption that describe self-interest as well as altruistic interests. This attempts to propose together with a self-interest model that is - UTAUT2 and a social-psychological model that is - norm activation model (NAM) that permit us to explain the expectancy-value foundations of EVs use, which fills this research gap. In addition, the age of individuals/consumers has a major impact on their behavior (Natarajan et al., 2018; Liébana-Cabanillas and Alonso-Dos-Santos, 2017). Some studies in mobile commerce such as Natarajan et al. (2018); and Liébana-Cabanillas et al. (2014) have examined that young respondents were more innovatory and happily accepted new technologies as opposed to older respondents. However, earlier studies in the field of EVADINT have not observed the moderation effects of age in general. Therefore, the moderating effect of age was used to examine whether EVADINT, will be decisive or not. To our best knowledge, these research gaps remain mostly understudied in the case of EVADINT.

Several researchers have investigated the factors of EVADINT from the individual and consumers' perspectives (Singh et al., 2020; Chu et al., 2019; Shankar and Kumari, 2019). These identified factors of EVADINT were expressed in terms of a variety of theoretical approaches as shown in Table1. Also, Table 1 shows that UTAUT and NAM are two governing theories in several earlier studies (Bhat et al., 2022; Gunawan et al., 2022; Ashraf Javid et al., 2021; Abbasi et al., 2021; Asadi et al., 2021; Hamzah and Tanwir, 2021; Jain et al. 2021; Khazaei and Tareq,

2021; Zhou et al., 2021; Wahl et al., 2020; He and Zhan, 2018; Rezvani et al., 2017). In the most recent study, Bhat et al. (2022) applied the UTAUT model to examine the EVs adoption by Indian consumers. Also, Jainet al. (2021) studied the integrated UTAUT model to forecast EVADINT in India combined with environmental concern, perceived risk, and government support. However, these studies did not discuss factors such as price value (PV), habit (HB), and hedonic motivations (HM). Zhou et al. (2021) employed the UTAUT2 model to analyze the EVADINT of taxi drivers from the perspective of China. Khazaei and Tareq (2021) used the UTAUT2 model to examine EVADINT in Malaysia. But the variables such as effort expectancy (EE), HB, and PV were not considered in this research. Gunawan et al. (2022) used an integrated model of UTAUT2-TPB to examine the EVADINT from the perspective of Indonesia. Wahl et al. (2020) developed the integrated UTATU-NAM model and findings showed that the performance expectancy (PE), EE, facilitating conditions (FCs), social influence (SI), and personal norms (PNs) significantly influence the EVADINT. However, the factors such as HM, PV, and HB were not considered in this research. Also, the moderation effect of age on EVADINT was not estimated. While the study of Asadi et al. (2021) employed a combined TPB – NAM model to predict the EVADINT in Malaysia and the findings predicted that the ascription of responsibility (AR), SI, consumer effectiveness, PNs, and awareness of consequences (ACs)impacted the EVADINT positively. Also, Hamzah and Tanwir (2021) employed a combined TPB – NAM model to investigate the factors influencing EVADINT of Malaysians. The results found that the perceived green value, perceived behavioral control, and SI impacted the EVADINT positively. Ashraf Javid et al. (2021) analyzed the EVADINT of travelers in Pakistan. The findings showed that the ascription of AR, ACs, socio-economic values, and PNs positively impacted the EVADINT. Similarly, He and Zhan (2018); and Rezvani et al. (2017) have used the NAM model to predict the EVADINT. These studies have identified the factors of NAM such as ACs, AR, PN, perceived consumer effectiveness, complexity, price, etc. By integrating UTAUT2 and NAM models, this research tried to bridge this gap.

Table 1
Review of literature on EVADINT.

Study	Theory	Construct	Country	Vehicle type
Adu-Gyamfi et al. (2022)	TAM, TPB	Attitude, subjective norm, perceived behavior control, perceived risk, knowledge, perceived usefulness	China	EVs
Bhat et al. (2022)	UTAUT	Performance expectancy, facilitating conditions, technological enthusiasm, technological enthusiasm, perceived benefits, social image, social influence, anxiety	India	EV
Gunawan et al. (2022)	UTAUT2, TPB	Performance expectance, effort expectancy, subjective norm, facilitating conditions, price value, habit, perceived behavior control, attitude towards use, risk perceptions	Indonesia	EV
Jaiswal et al. (2022)	SGT	Subjective norm, environmental concern, perceived knowledge, Perceived incentive policy, attitude, adoption intention	India	EV
Korkmaz et al. (2021)	UTAUT2	Performance expectance, effort expectancy, subjective norm, facilitating conditions, price value, habit, trust and safety, perceived risk, behavioral intention	Turkey	AV
Sahoo et al. (2022)	• TRA, TPB, MM	Personal positive motive, social motive, personal negative motive, attitude, buying involvement, word of mouth	India	EVs
Vafaei-Zadeh et al. (2022)	• TAM, TPB	Attitude, environmental self-image, perceived behavior control, perceived ease of use, perceived risk, perceived usefulness, price value, subjective norm, infrastructure barrier	Malaysia	EV
Xia et al. (2022)	• IDT	Perceived compatibility, perceived complexity, perceived relative advantage, economic aspect, social aspect, functional aspect	China	EV
Abbasi et al. (2021)	• UTAUT	Performance expectancy, effort expectancy, social influence, technophilia, perceived environmental knowledge, purchase intention	Malaysia	EVs
Asadi et al. (2021)	• TPB, NAM	Perceived value, attitude, perceived behavioral control, subjective norm, personal norm, perceived consumer effectiveness, financial incentives, awareness of consequences, ascription of responsibility, personal norm, intention to use	Malaysia	EVs
Ashraf Javid et al. (2021)	• Extended NAM	Reliable factors, awareness of consequences, ascription of responsibility, social values, personal preferences, economic values, willingness to buy and willingness to use, personal norms	Pakistan	EVs
Featherman et al. (2021)	• TRA, RBM	Perceived risk, perceived benefits, vendor trustworthiness, vendor expertise	USA	EVs
Hamzah and Tanwir (2021)	• TPB, NAM	Environmental concern, perceived environmental responsibility, perceived green value, green purchase attitude, perceived behavioral control, subjective norm, environmental knowledge, green purchase intention	Malaysia	HV
Ho and Wu (2021)	• TRAM, NAM	Technology readiness, perceived usefulness, perceived ease of use, intention to adopt, awareness of consequences, personal norm	Taiwan	ES

Jain et al. (2021)	• UTAUT	Performance expectancy, effort expectancy, social influence, facilitating conditions, perceived risk, environmental concern, government support	India	EVs
Jaiswal et al. (2021)	• TAM	Perceived usefulness, perceived ease of use, perceived risk, attitude towards EVs, incentive policies	India	EVs
Jayasingh et al. (2021)	• TPB	Environmental concern, perceived economic benefit, social influence, charging infrastructure, attitude	India	EVs
Khazaei and Tareq (2021)	• UTAUT	Social influence, facilitating conditions, range anxiety, and perceived enjoyment	Malaysia	EC
Malik, C., Yadav (2021)	• TRA, TPB	Past green behavior, environmental concern, social influence, consumer environmental, attitude, awareness of EVs, attitude, perceived economic benefit, purchase intention	India	EVs
Park et al. (2021)	• TAM	Perceived usefulness, perceived ease of use, social influence, and facilitating condition, intention to use AVs	South Korea	AV
Shalender and Sharma (2021)	• Extended TPB	Attitude, subjective norm, perceived behavioral control, moral norm, environmental concern	India	EVs
Wang et al. (2021)	• SCT	Social norm, environmental concern, face consciousness, incentive policy perceptions, attitude, adoption intention	China	BEV
Zhou et al. (2021)	• UTAUT2	Performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, habit, incentive policies	China	EVs
Kapser and Abdelrahman (2020)	• UTAUT2	Performance expectancy, effort expectancy, hedonic motivation, perceived risk, social influence, facilitating conditions, perceived risk, price sensitivity, behavioral intention	Germany	ADVs
Nordhoff et al. (2020)	• UTAUT2	Performance expectancy, effort expectancy, hedonic motivation, social influence, facilitating conditions, behavioral intention	Eight European countries	AC
Verma et al. (2020)	• IDT	Perceived compatibility, perceived complexity, perceived relative advantage, observability, EV market share awareness	India	EV
Wahl et al. (2020)	• UTAUT, NAM	Performance expectancy, effort expectancy, social influence, facilitating conditions, awareness of consequences, ascription of responsibility, personal norm, intention to adopt	Germany	BEV
Alzahrani et al. (2019)	• TRA	Subjective norm, environmental concern, HEV intention, attitude	Saudi Arabia	HEV
Higueras-castillo et al. (2019)	• PVT, TRA	Quality, emotion, price, social, acceleration, low noise, attitude, intention to adopt	Spain	EM
Huang and Ge (2019)	• TPB	Attitude, perceived behavioral control, subjective norm, cognitive status, product perceptions, non-monetary incentive policy measures, monetary incentive policy measures, purchase intentions	China	EV
Shankar and Kumari (2019)	• TPB	Environmental concern, attitude, social norm, perceived behavioral control, perceived obligation	India	EVs.

Tu and Yang (2019)	• TPB, TAM, IDT	Purchase intention, attitude towards behavior, perceived usefulness, perceived ease of use, compatibility, personal innovativeness, subjective norm, interpersonal influence, external influence, self-control ability, self-efficacy, facilitating conditions, perceived behavioral control	China	EV
Wu et al. (2019)	• TAM	Green perceived usefulness, environmental concern, perceived ease of use, behavior intention	China	AEV
Adnan et al. (2018)	• Extended TPB	Environmental concern, attitude, subjective norm, perceived behavioral control, personal norm, purchase intention, adoption of PHEV, hyperbolic discounting	Malaysia	PHEV
Haustein and Jensen (2018)	• TPB	Environmental concern, attitude, subjective norm, perceived functional barriers, busy life style, personal norm	Denmark, Sweden	EV
He and Zhan (2018)	• NAM	Awareness of consequences, ascription of responsibility, personal norms, perceived consumer effectiveness, perceived complexity, perceived price, intention to adopt	China	EV
Wang et al. (2018)	• TAM	Perceived usefulness, attitude, knowledge, perceived risk, adoption intention	China	EV
Han et al. (2017)	• CVT	Monetary value, performance value, convenience value, emotional value, social value identity, social value responsibility, epistemic value, attitude, adoption intention	China	EV
Nosi et al. (2017)	• TRA	Subjective norm, attitude, technological service, barriers, benefits	Italy	EC
Rezvani et al. (2017)	• Extended NAM	Moral norm, awareness of consequences, ascription of responsibility, positive anticipated emotions, negative anticipated, intention to adopt	Sweden	EV
Rahman et al. (2017)	• TAM, TPB, UTAUT	Attitude, performance expectancy, effort expectancy, perceived behavioral control, social influence, behavioral intention	USA	AV
Schmalfuß et al. (2017)	• Extended TPB	Subjective norm, attitude towards BEVs, perceived behavioral control, evaluation of product attributes	Germany	BEV
Note: EV- electric vehicle, PHEV- plug in hybrid electric vehicle, BEV- battery electric vehicle, HV- hybrid vehicle, EC- electric car, EM- electro mobility, ES- electric scooter, AEV- autonomous electric vehicle, ADVs- Autonomous delivery vehicles, AC- automated car, TAM- technology acceptance model, TPB- theory of planned behavior, TRA- theory of reasoned action, MM- motivational model, SGT- social cognitive theory, UTAUT- unified theory of acceptance and use of technology, RBM- risk benefit model, IDT- innovation diffusion theory, CVT- consumption value theory, PVT- perceived value theory, TRAM- technology readiness and acceptance model				

Objectives of the study:

- To develop the informational framework on the EVADINT in the Himalayan region.
- To identify the factors influencing the EVADINT in the Himalayan region.
- To evaluate the factors of the construct, such that they satisfactorily fulfill reliability & validity properties.
- To evolve understanding about the current state of infrastructure and barriers to the EVADINT in the Himalayan region and propose suggestions.
- Finally, it aims to deliver the policies suggestions and recommendations to increase the EVADINT in the Himalayan region

Methodology:

The description of working innovation (Figure 1) is outlined as follow:

Literature survey & Meta-analysis:

- This segment will perform meta-analysis and evolves research gaps in the target area.
- Also, this segment will frame the objectives of the research study based on the identified research gaps.

Theoretical framework and Hypotheses development

- This segment will develop a multivariate construct onthe EVADINT in the Himalayan region.
- Also, this segment will propose a research model of EVADINT based on the hypothesized relationships of each construct.

Questionnaire development and pretesting

- This segment will develop a questionnaire and this questionnaire will be pretested by the experts.

Data collection and data screening

- This segment will include the collection of data by using stratified random sampling.
- Also, in this segment Statistical Package for Social Sciences (SPSS) will be used to screen the data of this research in terms of coding, missing data, outliers (i.e., using Box and Whisker, normal probability plot), and normality (i.e., using skewness and kurtosis).

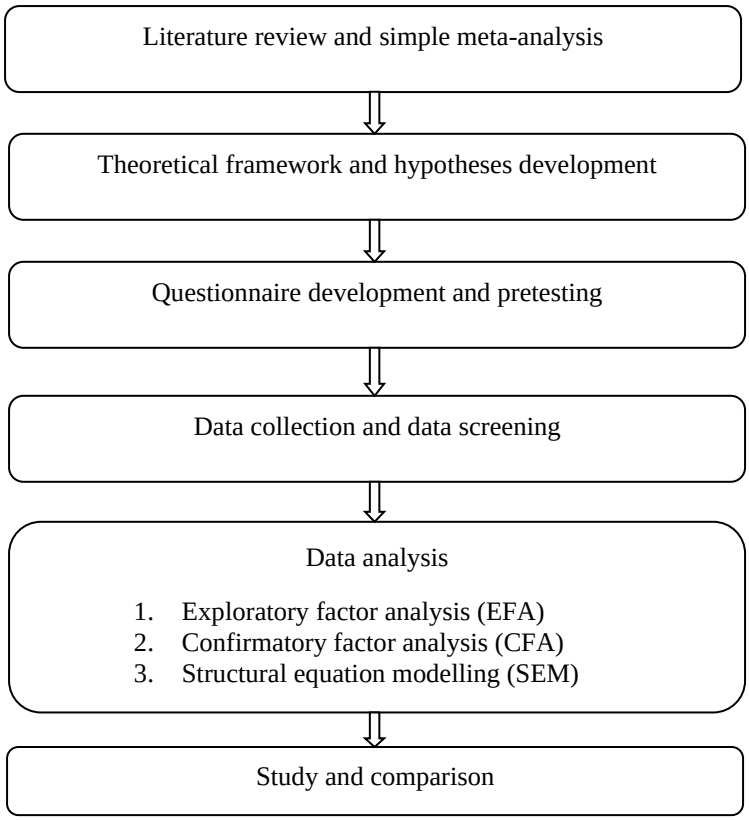
Literature review and simple meta-analysis
Theoretical framework and hypotheses development
Questionnaire development and pretesting
Data collection and data screening
Data analysis
1. Exploratory factor analysis (EFA)
2. Confirmatory factor analysis (CFA)
3. Structural equation modelling (SEM)
Study and comparison

Figure 1: Description of working methodology

Data analysis

- This section will analyze the collected data by using exploratory factor analysis, confirmatory factor analysis, and structural equation modelling. After then, the underlying dimensions will be checked for reliability and validity. This will explore the underlying dimensions/ measures of EVADINT. Finally, the identified underlying dimensions will lead to develop the Structural Equation Model on theEVADINTin the Himalayan region.

Expected outcomes:

This study is expected to provide insights into the factors that influence the intention to adopt EVs in the Himalayan region and validate the UTAUT2-NAM model in the context of EV adoption. The study will also examine the mediating effects of attitude towards EVs and perceived behavioral control on the relationship between factors and intention to adopt EVs. The finding of this study will contribute to the development of effective strategies for promoting EV adoption in the Himalayan region and other similar contexts.

Conclusion:

This study aims to investigates the intention of consumers in the Himalayan regions to adopt EVs using the UTAUT2-NAM model and apply SEM to validate the model .The study is expected to provide insights into the factors that influence the intention to adopt EVs in the Himalayan region and contribute to the development of effective strategies for performing EV adoption in the region The finding of the study will also have implication for other similar contexts where EV adoption is being promoted.

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